DISSERTATION ON

A STUDY OF PHONOSURGERIES IN VOCAL DYSFUNCTION

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CERTIFICATE

*This is to certify that this dissertation entitled "**A STUDY OF PHONOSURGERIES IN VOCAL DYSFUNCTION"** submitted by **Dr. PRAVEEN KUMAR M.,** appearing for **M.S., Branch-IV (Oto-rhino-Laryngology)** Degree examination in March 2008, is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of regulation of the Tamil Nadu Dr.M.G.R. Medical University, Chennai. I forward this to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India.*

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CONTENTS

INTRODUCTION

Phonosurgery essentially is surgery defined to improve or restore voice. To accomplish such a goal, it is often necessary to remove diseased tissues, but eradication of diseases alone is not a sufficient measure of success in phonosurgery. Phonosurgery must be distinguished from conservation laryngeal surgery where the primary aim is eradication of the cancer and voice restoration is a secondary - albeit important - consideration.

Dysphonia is the presenting symptom of the phonosurgical patient. The pathologic condition may include various benign vocal fold lesions or diseases affecting the neuromuscular function of the larynx. Dysphonia may result also from the normal aging process, excessive use and vocal abuse. There are many surgical approaches in phonosurgery and techniques continue to evolve. In this study, phonomicrosurgery and medialization laryngoplasty using Gore-Tex are described and their outcome analysed. Although surgical technique is an important determinant of outcome, diagnostic assessment, and surgical indication desire equal attention. It is always necessary to perform a comprehensive voice evaluation, identify the pathologic condition and recognize the appropriate surgical candidate before surgery. Excellent techniques cannot offset the damage done when surgery is performed on the wrong patient or for a nonsurgical problem.

The team consists of a laryngologist and a speech pathologist (or phoniatrician) who are knowledgeable about voice production & pathology. Careful assessment should be done preoperatively to describe and localize the pathological condition. This is essential to treatment planning.

Normal voice production requires a timely tuned neuromuscular system and mechanical integrity of the vocal folds. Some dysphonia can be corrected with voice therapy. However, when there is structural abnormality or irreversible neuromuscular damage, phonosurgical intervention is indicated.

Phonosurgery should correct the mechanical problem without producing substantial secondary problem. Avoidance of secondary intention healing in the membranous vocal fold and appreciation of the histoarchitecture of the vocal fold will help the phonosurgeon avoid disastrous result.

Vocal fold paralysis may be treated by voice therapy, implant, injection, framework surgery, and restoration. The results depend on the technique, materials and physiological and psychological status of the patient.

In this study of phonosurgeries in vocal dysfunction, the patients who failed conservative therapy are categorized based on their lesions and the outcomes of various phonosurgical techniques (including phonomicrosurgery and medialization laryngoplasty) are analysed.

AIMS OF THE STUDY

The present study on phonosurgeries is undertaken

- To analyse and categorize the various benign lesions of the vocal cord causing vocal dysfunction requiring phonosurgeries.
- To analyse the incidence and distribution of cases according to the age, sex and etiology among the patients who require intense medical and voice therapy with surgical intervention.
- To describe various available investigatory tools for analyzing the voice and larynx.
- To describe various techniques of phonosurgery including phonomicrosurgery and medialization laryngoplasty using Gore-Tex (expanded polytetrafluoroethylene-ePTFE) in vocal dysfunction.
- To analyse the outcomes of phonomicrosurgery and medialization laryngoplasty using Gore-Tex(expanded polytetrafluoroethylene-ePTFE).

REVIEW OF LITERATURE

1963	*Hans Von Leden*[1] first coined the term 'phonosurgery'. The term phonosurgery refers to any surgery designed primarily for the improvement or restoration of voice. In 1986, 'Koufman' coined the term 'medialization laryngoplasty'.
1854	Spanish singing teacher Manuel Garcia first observed his own larynx with the aid of a small dental mirror.
1987	Prague Physiologist *Johann Nepomuk Czermak* popularized the indirect visualization of the larynx.
1895	Professor *Alfred Kirstein* in Berlin developed the art of direct laryngoscopy.
1950's	Professor *Oskar Kleinsasser*[2], an Austrian, impresses with the result of microscopic examination of the uterine cervix and perfectionized the microscopic techniques and diagnostic facilities of the larynx.
1968	Kleinsasser published his comprehensive book on microlaryngoscopy with magnificient magnified photographs of the larynx. *Chevalier Jackson*, an American laryngologist, pioneered the endoscopic laryngeal technique.
1950	*Geza Jako*[3] in Boston developed an improved laryngoscope for binocular diagnosis and bimanual surgery.
1962	*Jako* designed a series of microlaryngeal instruments.
1911	*Wilhelm Brunings*[4], at the 18th annual Meeting of the German Laryngological Society, presented an ingenious and novel technique for the relief of aphonia in patients with unilateral vocal fold paralysis. He described the injection of paraffin into the paralyzed vocal fold of patients.
1957	*Dr.Godfrey Arnold* of New York, at the VI International Congress of Oto-Rhino-Laryngology in Washington described successful vocal fold injections using diced autogenous cartilage from the nasal septum in place of paraffin.
1915	*Professor Dr. Erwin Payr* of Leipzig, serving as a general in the medical Department of the German Army during World War-I described the medialization laryngoplasty in unilateral vocal fold paralysis.
1942	During World War-II, the Finnish laryngologist, Professor Yrjo Meurman of Helsinki reported the implantation of a sliver of autogenous costal cartilage for medialization of vocal fold.
1974	*Professor Nobuhiko Isshiki*[5] at the University of Kyoto in Japan introduced modern laryngoplastic techniques. He described four basic procedures to alter the laryngeal skeleton and thereby the resulting voice. He also described arytenoid adduction.
1975	*Professor Minoru Hirano*, Kyoto University, another pioneer in phonosurgery, gave numerous presentation & publishments in phonosurgery.
1983	*Francis Le Jeune* of the Ochsner Clinic in New Orleans described an advancement of the anterior commissure to tighten the vocal ligament and strengthen the voice.
1969	*Professor Paul Kluyskens* of the University of Ghent in Belgium has succeeded in the goal of laryngeal transplant surgery.

DESCRIPTIVE ANATOMY OF LARYNX

DEVELOPMENT

From laryngo tracheal bronchial groove
The larynx is divided into three subsites.

Supraglottis-	Epiglottis, Aryepiglottic fold, Arytenoids and Ventricular band
Glottis-	Vocal cords, Anterior and Posterior Commissures
Subglottis-	Under surface of cord and mucous membrane covering inner surface of Cricoid.

MUCOUS MEMBRANE

Respiratory epithelium in supraglottis and subglottis
Squamous epithelium in glottis
Mucous glands are absent in vocal cords but rich in ventricles
Frame work

Cartilages which are three unpaired cartilages and three paired cartilages. (Fig.1)

UNPAIRED CARTILAGES

1. Epiglottis- leaf like
2. Thyroid- shield like
3. Cricoid- signet ring shaped

PAIRED CARTILAGES

1. Arytenoids-over the lamina of the cricoid
2. Corniculates-over the arytenoids
3. Cuneiforms-in the aryepiglottic fold

LIGAMENTS

Extrinsic and Intrinsic ligaments

EXTRINSIC

1. Thyrohyoid ligament
2. Hyoepiglottic ligament
3. Cricothyroid ligament

INTRINSIC

1. Conus elasticus-vocal cord to upper surface of cricoid
2. Quadrangular membrane-ventricular band to aryepiglottic fold

MUSCLES (FIG.2)

1. Extrinsic

1. Elevators-Supra hyoid muscles
2. Depressors-Infrahyoid muscles

2. Intrinsic

1. Abductors - Posterior cricoarytenoid
2. Adductors - Interarytenoids, Thyroarytenoids, Lateral cricoarytenoids
3. Tensors- Vocalis, Cricothyroid

SPACES

1. Reinke's space-subepithelial space of vocal cords
2. Paraglottic space-between inner surface of thyroid cartilage and intrinsic ligaments
3. Preepiglottic space-anterior to epiglottis on either side communicates with paraglottic space

BLOOD SUPPLY

1. Superior laryngeal vessels
2. Inferior laryngeal vessels

LYMPHATICS

Pretracheal, Paratracheal, upper and lower deep cervical nodes

NERVE SUPPLY (FIG.3)

Superior laryngeal and recurrent laryngeal nerves of vagus

PHYSIOLOGY OF LARYNX

The function of the larynx can be broadly classified into:

1. Respiratory air channel and airflow regulation: The larynx is a part of tubal system for the passage of air from the lungs. During normal respiration the cords are relaxed and halfway between adduction and full abduction.
2. Sphincteric function: The primary sphincteric action of the larynx is to protect the tracheobronchial tree during swallowing and vomiting. The sphincters in cephalo-caudal directions are 1.AE fold, 2. Vestibular folds, 3.Vocal folds
3. Receptive field for reflexes: cough reflex.
4. Phonation and speech: voice is the musical sound produced by vibration of the vocal cords in the larynx by air from the lung.

PHONOSURGICAL ANATOMY OF THE NORMAL LARYNX

Anatomy of the glottic region:

The glottis is anatomically divided into two parts - the inter membranous portion or anterior glottis and the inter cartilaginous portion or posterior glottis. These two parts are separated by a line between the tips of the bilateral vocal processes.
In adults, the ratio of the anteroposterior dimension of the intermembranous portion to that of the intercartilaginous portion is about 3:2 and the ratio of the area of the intermembranous portion to that of the intercartilaginous portion is about 2:3[6].
Anatomically, the vocal fold is defined as the fold like structure, between the anterior commissure and the vocal process of the arytenoid cartilage.

Histological structure of the adult vocal fold:

The vocal fold comprises mucosa & muscle. The mucosa, inturn is made up of the epithelium and lamina propria. The epithelium is stratified squamous cell epithelium around the edge of the vocal fold, and at this edge, the lamina propria consists of superficial, intermediate & deep layers.
The superficial layer of lamina propria, referred to as Reinke's space is composed mainly of an amorphous substance and is loose and pliable. It is this layer that vibrates most significantly during phonation. If this layer becomes stiff due to some pathological state (e.g., inflammation, tumor, or scar tissue) its vibrations are disturbed and voice problems result.
The intermediate layer is primarily elastic fibres, and the deep layer is primarily collagenous fibres. The intermediate and deep layer of the lamina propria together form the vocal ligament. Deep to the vocal ligament is the vocalis muscle that constitutes the body of the vocal fold.
Around the edge of the vocal fold, the elastic and collagenous fiber in the lamina propria, as well as the muscle fibres of the vocalis muscle, run roughly parallel to the edge. This arrangement facilitates vibratory movements of the fold.
No glands are evidence in the mucosa around the edge of the vocal fold. Glands here would add resistance and impede vibratory motion.

CONCEPT OF COVER - BODY COMPLEX: (FIG.4)

The vocal fold is a multilayered vibrator, and this is its most important characteristic for vocal function or vocal fold vibration.
From the standpoint of mechanics, the epithelium can be considered a thin capsule of the vibrator. The superficial layer of the lamina propria can be likened to a mass of soft gelatin, where the elastic fibers are analogous to soft rubber band and the collagenous fibers are analogous to cotton thread. Tissue stiffness thus increases from the very pliable superficial layer of the lamina propria to the contracting muscle.
The five histological layers[7] can be reclassified into three section: The cover, consisting of the epithelium and the superficial layer of the lamina propria; the transitional portion, consisting of the intermediate and deep layers of the lamina propria or the vocal ligament and the body, consisting of the vocalis muscle.

AETIOPATHOGENESIS OF BENIGN LESIONS CAUSING VOCAL DYSFUNCTION

VOCAL NODULES: (FIG.5)

The term nodules should be reserved for lesions of proven chronicity. Vocal nodules occur most commonly in boys and women. Such persons are almost always "Vocal Over-doers".
Fluid accumulation in the submucosa from acute abuse or overuse results in submucosal swelling. Long term voice abuse leads to some hyalinization of Reinke's potential space & possibly some thickening of the overlying epithelium.
They usually occur around the edge at the anteroposterior midpoint of the membranous vocal fold. They are whitish, small, sessile, and usually bilateral. The lesion is confined to the superficial layers of the lamina propria and primarily consists of edematous tissue or collagenous fibers or both. The mass and stiffness of the cover are increased slightly, but the mass and stiffness of the transition and body are not affected[8].
Surgical intervention should be strictly confined to removing the excess small mass. A straight edge along the vocal fold and only a minimal wound should be the result.

VOCAL FOLD POLYP: (FIG.6)

It is more common in men, particularly, those who engage in intermittent severe voice abuse or who work in noisy environment.
Shearing forces acting on capillaries within the mucosa during extreme vocal exertion lead to capillary rupture. Extravasation of blood and accumulation of edema from a deeper capillary may lead to pooled blood, similar to a blood blister.
They usually develop around the edge of the fold at the middle of the membranous vocal fold. They may be reddish or whitish, small or large, sessile or pedunculated, unilateral or bilateral.
The mass of the cover increases, the stiffness of the cover varies according to the pathology. The mechanical property of the transition and body are not affected.
Surgical removal should be confined strictly to the excess mass. A straight edge along the vocal fold and only a minimal wound should be the result.

INTRACORDAL CYST: (FIG.7)

The most prominent epidemiologic finding is a history of vocal overuse. This is routine for the epidermoid cyst, but less so for the mucus retention variety.
Histologically, intracordal cyst are classified as either mucus's retention or epidermoid inclusion types (common type). Mucus retention cysts arise when the duct of a mucus gland becomes plugged and retaining glandular secretion; epidermoid cysts contain accumulated keratin. Mucus retention cysts can arise seemingly spontaneously.
Cysts usually are located in the superficial layer of the lamina propria. Occasionally cysts open to the laryngeal lumen or partly insert into the vocal ligament or both. The cyst wall is lined with thin squamous epithelium.
The mass and stiffness of the cover increase, but the mass and stiffness of the transition and body

usually are unaffected.
The object of surgery for cysts[9] is an enucleation of the lesion with minimal injury to the surrounding normal tissue. The mucosa that covers the cyst should be preserved.

REINKE'S EDEMA (OR SMOKER'S POLYP): (FIG.8)

It has been referred as polypoid degeneration, chronic polypoid corditis, chronic edematous hypertrophy and polypoid vocal fold.
Smoking and a degree of talkativeness are required to develop this disorder. There also seem to be an individual susceptibility to this condition because only a small percentage of persons at risk develop it. Chronic smoking and vocal abuse result in edema, vascular congestion and venous stasis.
The membranous vocal fold is edematous and swollen along the entire length. Histologically, the primary feature of the lesion is edema in the superficial layer of the lamina propria. The lesion is usually bilateral but frequently is asymmetrical.
The mass of the cover increases, but the stiffness of the cover usually decreases. The mass and stiffness of the transition and body are not affected.
The surgical goals may entail both a judicious resectioning of redundant mucosa and conservation of sufficient mucosa to prevent healing by second intention.

INTUBATION GRANULOMA: (FIG.9)

Intubation granuloma, occur in patients who have undergone endolaryngeal surgery affecting the arytenoids perichondrium, acute or chronic intubation, rigid bronchoscopy or other direct laryngeal manipulations.
Granuloma after intubation can occur because of direct abrasion of the arytenoid perichondrium, a break in the mucosa covering it as a result of coughing on an endotracheal tube, or long-term pressure necrosis of the vocal process area.
The granuloma can vary in size but is often large and sessile with some pedunculation. They are frequently bilateral. The membranous vocal fold is not affected[10].
The mechanical properties of each layer of the membranous vocal fold remain normal.

KERATOSIS LARYNX: (FIG.10)

The term keratosis implies pathology in which a hyperplastic thickening of the epithelium is the primary lesion. When the affected epithelial cells show atypia, the lesion is called epithelial dysplasia. Smoking & alcoholism are the main etiological factors. The lesion originates from the epithelium and may enter the superficial layer of the lamina propria. The vocal ligaments and the muscle are never involved unless the lesion becomes malignant. Mass & Stiffness of the cover increase. Surgical intervention should be confined to the epithelium and the superficial layer of the lamina propria.

VOCAL CORD PAPILLOMA: (FIG.11 & 12)

Squamous papilloma are the most common benign neoplasm seen by laryngologists. Jones, Myers and Baines found that 84% of the benign laryngeal tumour they managed were papillomas. Regarding recurrent respiratory papillomatosis, it occur at a rate of 4.3 per 1,00,000 children and 1.8 per 100,000 adults. It occurs in response to mucosal infection by human papilloma virus of the Papova class. Adult-onset papillomas are occasionally solitary or at least more localized than juvenile-onset ones. Behaviour of adult-onset papillomatosis may also be less aggressive and rarely a single removal alone is necessary for complete cure.

Papillomas originate from the epithelium and usually invade the lamina propria. The lesion is asymmetrical and may be either unilateral or bilateral. Proliferated neoplastic epithelial cells growing in a papillary fashion are histologically evident. The mass and stiffness of the cover increases. The mass and stiffness of the transition and the body also increase when these structures are affected.
The goal of surgery for vocal fold papilloma is to eradiate the neoplastic lesion while only minimally affecting the normal vocal fold tissue. This goal is however, very difficult to achieve in most cases.

VOCAL CORD PARALYSIS: (FIG.13)

Nerve paralysis can be classified into three neuropathological types: neuropraxia, axonotmesis and neurotmesis. In axonotmesis, the axons of the nerve are sectioned, and in neurotmesis, the nerve fibres are cut entirely. In both axonotmesis and neurotmesis, the nerve segment peripheral to the site of the lesion degenerates and the muscle is denervated. The nerve may or may not regenerate, and then the muscle may or may not be reinnervated. If the muscle is not reinnervated, it atrophies.
Unilateral recurrent nerve paralysis is more frequent than bilateral paralysis. Glottic closure is usually is incomplete because the affected vocal fold can not be adducted.
When vocal fold paralysis is associated with muscle atrophy, the mass & stiffness of the body decreases. The mechanical properties of the cover and the transition are basically unaffected.
The left recurrent laryngeal nerve is more frequently involved, undoubtedly because of the longer course. Comparing many series, surgery is still responsible for more recurrent laryngeal nerve paralysis than tumour. Thyroid surgery, anterior approaches to the cervical spine, carotid endarterectomy and skull base operation are the most common surgeries causing damage.
Netterville et al found thyroid surgery to be the most common cause of iatrogenic recurrent laryngeal nerve paralysis.

INVESTIGATIONS

1) Indirect laryngoscopy:

It is an OP procedure, it gives an idea of the nature of the lesion, site of the lesion & its extent, mobility of the vocal cords, presence of phonatory gap etc.

2) Direct Laryngoscopy:

It is to confirm the IDL findings and to examine the nature of the lesion, whether benign or malignant. Probing of the lesion can be done to identify its relation to the deeper structures of the vocal cord.

3) Flexible Fibreoptic Scopy:

It is done under local anesthesia. It gives sufficiently highly magnified and detailed three dimensional picture of the larynx whereas the direct laryngoscopy gives two dimensional picture.

4) Radiological Investigation:

a) X-ray soft tissue neck lateral view:

To assess the subglottic aircolumn & tracheal lumen.

b) X-ray Chest PA view:

To look out for pulmonary tuberculosis, malignancy of lung, mediastinal tumor in case of assessment of vocal cord palsy and for anaesthetic fitness purpose.

c) X-ray skull base:

Petrous bone, nasopharynx to rule out skull base tumors in vocal cord palsy.

d) X-ray Barium swallow:

To look out for aero digestive tract lesions or malignancies in case of vocal cord palsies.

e) CT Scan:

When there is no other detectable lesion that explains the paralysis and involvement is limited to the vocal fold (i.e. there is no weakness of palate or pharynx), a contrast CT scan covering the course of the recurrent laryngeal nerve from the skull base to the upper mediastinum is indicated. If this reveals no mass lesion to explain the paralysis, then it is categorized as idiopathic vocal cord palsy[11].

5) Panendoscopy:

It comprises, direct laryngoscopy, esophagoscopy and bronchoscopy to detect any mass lesion that is causing vocal cord palsy, where there is no other relevant history or examination to identify the etiology of vocal cord palsy.

6) Electroglottogram:

Using two electrodes on the skin over thyroid lamina, passing weak frequency voltage from one electrode to the other and making patient to phonate a transverse impedance of variation of electric current in phase with vocal cord vibration is noted which can be recorded also. This tracing is called electroglottogram which can be correlated with stroboscopic studies.

Doctor speech is a software by which voice can be analysed. The exact fundamental frequency of the person's voice will be measured and displayed. The voice quality viz., breathiness, harshness and hoarseness are expressed in ratings of mild, moderate and extreme.

7) Examination of voice and larynx:

Vocal capability Battery[12]:

a) Speaking Voice:

The patient is asked to read a couple of sentences of a standard phonetically balanced passage at conversational volume. The voice may be quite breathy, weak & unfocussed in vocal cord palsy.

b) Projected Voice:

The patient is asked to read briefly from the same passage in projected voice, as though speaking to a crowd. These tasks often unmask the paralytic dysphonia.

c) Vocal range:

The extent of the patient vocal range is elicited by asking the patient to go higher or lower until the limits are reached. It most often exhibits some limitations at its upper extent.

d) Vocal Manifestations of forceful cough:

The cough may be non percussive.

e) Maximum phonation time (MPT):

The patient is asked to take a deep breath and then to phonate continuously at a given pitch. Patients with vocal fold paralysis are expected to have a reduced MPT - generally less than 10 seconds and often between 2 and 5 seconds.

Flexible Endoscopic Evaluation:

During quite breathing, the vocal folds are evaluated for the following features[13]:

- Rest position: Rest position of the cord along with degree of atrophy and flaccidity of the vocal fold and the patients ability to overadduct the fold are of great importance.
- Position and direction of the vocal process in relation to each other.
- Symmetry of vocal fold contour - to look for atrophy of vocal fold musculature; to look for capacious ventricle on affected side.
- Evidence of synechia in the posterior glottis.
- Scarring along the cricoarytenoid joint capsules.
- Subglottic and tracheal granulation, scarring or stenosis, which should increase suspicion of joint ankylosis.

During phonation, the following should be observed:

- Mobility of the membranous part of the vocal folds as compared with the body and apex of the arytenoids.
- Glottic closure.
- Level of match between vocal processes[14].
  If the vocal processes are on the same horizontal plane, despite the appearance of a displaced or anteriorly prolapsed arytenoid body and apex, the arytenoids cannot have been dislocated. The vocal fold must be paralyzed instead.
- Flaccidity of vocal fold structures.
- Lesions in the trachea or mainstream bronchi or a trail of blood.

8) Manual Compression Test (Gutzmann Test):

If the membranous part is affected with unilateral vocal cord paralysis, then firm pressure over the thyroid lamina of the affected side and asking the patient to phonate will improve the quality of voice. If this improvement is noticed with this test, then it could be possible to correct the vocal cord palsy with medialization laryngoplasty.

PHONOSURGERY

All surgeries that deal with function of phonation can be called phonosurgery[15].
The broad category of phonosurgery includes

- Endoscopic phonomicrosurgery
- External laryngoplastic phonosurgery.
- Nerve-muscle surgery of the larynx.

Today, phonosurgical procedures are most often performed to correct laryngeal incompetence in the patient with vocal fold paralysis, atrophy or scarring. The two most commonly performed procedures to correct glottic incompetence are medialization laryngoplasty and arytenoid adduction.

Phonosurgery procedures:

- Laryngeal framework surgery
    - Vocal fold medialization
    - Vocal fold lateralization
    - Cricothyroid approximation
    - Arytenoid adduction
    - Anterior commissure advancement
    - Anterior commissure set back
- Phonomicrosurgery and vocal fold cover restoration
- Nerve muscle surgery
    - Thyroarytenoid myectomy
    - Recurrent nerve section
- Injection laryngoplasty
    - Poly tetra fluoroethylene (Teflon) injection
    - Collagen injection
    - Fat injection

PREOPERATIVE VOCAL REHABILITATION:

All patients are subjected to preoperative voice therapy that includes the voice pathologist preparing the patient for postoperative voice rest/use, discussion of the importance of optimal vocal hygiene, and control of reflux in the pre and postoperative period. Patients are educated about the importance of vocal hygiene, smoking cessation and reflux control, the nature and risks of surgery, and post operative recovery phase.
Good vocal hygiene include reduction of vocally abusive behaviours such as throat clearing, frequent hard glottal attacks, yelling or speaking incorrectly, and conditions such as dehydration and gastroesophageal reflux and smoking.
The medication to be avoided are nonsteroidal anti-inflammatory drugs that increase the risk of vocal fold haemorrhage, antihistamines that dry and alter the viscosity of secretions and inhaled medications like pulmonary steroids & bronchodilators that cause mucosal irritation and drying.

Relaxation exercises are given to eliminate excess tension and are usually directed at the head and neck, shoulders, overall posture, tongue, jaw and throat.

PHONOMICROSURGICAL TECHNIQUE

General Principles:

Phonomicrosurgery is a mean of maximally preserving the layered microstructure of the vocal fold, that is, the epithelium and laminapropria[16].
Precision is paramount in the execution of effective endolaryngeal surgery.
The anterior commissure deserve particular attention so that healthy mucosa is preserved on at least one vocal fold edge at the commissure.
Avulsion should be avoided and avulsion technique lacks precision and can result in tearing and shredding of mucosa.
Dissection is performed after the mucosa overlying the vocal fold is incised with a sharp scalpel. This cordotomy approach allows separation of lesion from the overlying mucosa and laterally placed vocal ligaments.
Healing is promoted by a careful coaptation of the tissues after dissection[17].

Anaesthesia:

General anaesthesia with smallest possible endotracheal tube.

Instruments: (Fig.14)

- Kleinsasser suspension laryngoscope with the largest possible lumen[18].
- Operating microscope with a 400mm objective lens.
- Microinstruments
    - Cup forceps- straight and angled.
    - Alligator forceps-straight and angled
    - Sickle knife
    - Microscissors - curved (right & left)
    - Suction tips of appropriate length.
    - Insulated diathermy probe.

Position of the patient: (Fig.15)

The patient is placed in the classic Boyce - Jackson position with the neck flexed and the head extended at the atloid - occipital joint.

Procedure: (Fig.16-20)

The laryngoscope is placed between the endotracheal tube and the infrapetiole region of the supraglottis as well as between the vestibular folds to provide complete internal distension of the supra glottal structures[19].
Topical anesthesia is applied with epinephrine 1:10,000 to achieve hemostasis.
Phonomicrosurgical procedures frequently begin with cold instrument epithelial incision, which is referred to as an epithelial cordotomy[20,21]. This initial incision facilitates microscopic exploration of the relationship of the lesion to the superficial lamina propria. This mucosal flap is elevated and the underlying lesion is encountered. Dissection of the lesion is performed using a combination of blunt and sharp microlaryngeal instruments. The lesion is carefully separated from the vocal ligament and the overlying mucosal cover and is removed. The preserved mucosal flap is redraped serving as a biologic dressing.
The diffuse polypoid change seen in Reinke's edema is also treated with a cordotomy approach, but

excess epithelium is usually excised to prevent imbrication of the redundant mucosal cover. The goal for all these techniques is the same: to provide an intact mucosal cover over the underlying lamina propria[22].
Small vocal cord lesions and polyps with peduncles are grasped with grasping forces, pulled medially and are amputated with microscissors without damaging the underlying microstructures.

Post operative care:

Patients are placed on strict voice rest for one week. After that, gradual resumption of voice under the guidance of speech pathologist is commenced. Antibiotics, steroids or analgesics are prescribed selectively.

Complication of Microlaryngeal Surgeries:

Most common include - tongue numbness, altered taste, minor trauma to teeth, oral cavity, and pharynx during rigid laryngoscopy. Laryngospasm can occur during emergence from anesthesia and extubation. Risks associated with phonomicrosurgery include the potential for worsened voice quality, bleeding, infection, dental trauma and oropharyngeal injury due to laryngeal suspension and most notably, scar formation due to over aggressive tissue resection or patient factors during healing period.

MEDIALIZATION LARYNGOPLASTY:

This is type-I thyroplasty in which an implant is placed between the thyroid cartilage and the vocalis muscle to medialize the membranous vocal fold[23]. This is the most popular type of laryngeal framework surgery, because it addresses the most common clinical disorder of glottic incompetence caused by vocal fold paralysis. The arytenoids rotation technique and the arytenoid adduction procedure are supplemental procedures used with medialization laryngoplasty to correct the posterior chink and the arytenoid malrotation which are often present in patients with vocal fold paralysis[24].

Indications for medialization laryngoplasty:

- Patient with glottic incompetence resulting in poor phonation, poor cough and aspiration may be a candidate for medialization laryngoplasty[25].
- Vocal fold paralysis causing above symptoms.
- Vocal fold scarring and atrophy.
- Sulcus vocalis, presbyphonia.
- Scarring after partial laryngectomy.

Relative contraindication[26]:

- Patients with bleeding disorder.
- Immunocompromised patients.
- Patient who must undergo chemotherapy may have poor wound healing.
- Patients with severe pulmonary compromise caused by previous pneumonectomy, COPD.
- Medically ill patients.

Various material used[27]:

- Silastic implant system
- Titanium implant system
- Gore-Tex implant system (expanded polytetrafluoroethylene)
- Hydroxyapatite implant system
- Other plastic materials.

Surgical Technique: (Fig.21 - 22)

Medialization laryngoplasty is done under local anesthesia with adequate sedation and analgesia while allowing the surgeon to test the voice. Local anesthesia is obtained by injection with 1% lignocaine with 1: 100,000 adrenaline over the thyroid cartilage. Deep injections to the thyroid perichondrium are performed after the superficial injection.

A horizontal cervical incision[28] is made over the middle of thyroid cartilage and subplastysmal flap is elevated superiorly upto the hyoid bone and inferiorly upto the cricoid cartilage.

- The strap muscle is incised in the midline raphe and retracted to reveal the thyroid cartilage.
- The thyroid cartilage of the paralyzed larynx is rolled to the midline and into operative view.
- A wide inferiorly based U-shaped perichondrial flap is then created over the thyroid cartilage.

The key landmarks[29] for making the thyroplasty window at the level of vocal folds are the midline of thyroid cartilage, inferior border of the thyroid notch, and the inferior border of thyroid cartilage. The vocal folds are at the bottom half of the thyroid cartilage. First, the distance from the bottom of the thyroid notch to the inferior border of thyroid cartilage is measured with a caliper. This distance is divided by two to determine the top line for the thyroplasty window.

The important aspects for the creation of window are:

1) The anterior incision is set back at least 5 mm from the midline.
2) The thyroplasty window is centered with the limbs parallel to the inferior border of the thyroid cartilage and
3) The window is centered on the lower half of the thyroid cartilage to avoid medialization of the false vocal folds.

The cartilage window is removed while preserving the inner perichondrium. A small spatula or elevator is used to push the inner perichondrium away gently. The wedge shaped implant is placed in the window after testing the voice by pushing on the thyroarytenoid muscle with an elevator inserted through the window.

Medialization laryngopalsty using Gore-Tex:

Gore-Tex implant cut into thin strip is progressively inserted into the window lateral to the inner perichondrium and the voice of the patient is tested on table along with visual feedback from flexible laryngoscopy. The Goretex implant can be easily adjustable[30] according to voice improvement of the patient. The voice should be of appropriate pitch. It should be devoid of strain or breathiness and should have a good dynamic range from soft voice through loud phonation. To reduce complaints of dyspnea during phonation, a phonation time longer than 8 seconds is desirable[31].

After the placement of implant, the cartilage is replaced and secured in place with prolene sutures. A small rubber drain is kept and the incision closed in layers. Voice rest is advocated for the first week to allow the implant to set without disturbance. Voicing is permitted at one week. Voice therapy is instituted 1 to 3 weeks after surgery.

Complications[32,33]:

Major:

a) Wound haemorrhage

b) Airway obstruction

c) Prosthesis extrusion (both internal and external extrusions)

d) Failure to improve voice quality

Minor**:**

a) Vocal fold haematoma without airway compromise or prosthesis movement

b) Wound infection

c) Chondritis

Advantages of Gore-Tex Impant:

- Gore-Tex was introduced by Hoffman and McCulloch.
- Its advantages are:
  - Ease of Handling
  - Ease of placement
  - Can be easily adjustable even while the implant remaining within the patient.
  - Enhance the speed of surgery
  - No complex measurements of window need to be created.

Disadvantages of Gore-Tex:

a) Tissue reaction (very rare)

b) Potential for migration of the implant within the paraglotticspace either acutely or over time.

Injection Laryngolpasty:

Autologous fat and cymetra (human micronized alloderm) are the most common materials used today. Cymetra has been shown to provide excellent phonatory results lasting 6-12 months with little or no inflammatory response. The hyaluronic acid formulations such as Hylan B gel has also been shown to have favourable viscoelastic properties. Bovine collagen injection can result in increased tissue stiffness and less than satisfactory results. Permanent adverse reactions are unlikely to occur. The use of Teflon is discouraged unless long term patient survival is not anticipated. Adverse reaction like Teflon granuloma can occur[34].

The various approaches for injection laryngopalsty are:

a) Percutaneous injection

b) Transoral injection

c) Laryngoscopic injection.

Complications of vocal fold injection include[35]:

- Under injection requiring repeat procedures
- Over injection with airway compromise
- Improper placement causing subglottal extension & potential stenosis
- Intracordal injection of Teflon impairing vibratory capability.
- Granuloma formation

LASER IN LARYNGOLOGY:

Carbon Dioxide Laser:

Polanyi, Jako, Strong & Vaughan introduced carbon Dioxide (CO_2) laser[36] to surgery in the 1970's. CO_2 laser is a fundamental tool for the endolaryngeal surgeon, however its use has been limited to the operating room because the energy can not be delivered through a fiber. Wavelength is 10.6 μm in the infrared lesion. Optimal subepithelial resection of common vocal fold lesion such as nodules, polyp & cysts is impossible with a CO_2 laser.

585-nm pulsed dye laser:

The presumed mechanism of disease regression is the selective destruction of the subepithelial microvasculature. It is used to enhance cold instrument microflap epithelial resection. It is also effective in treating papillomatosis and dysplasia.

532-nm KTP laser:

It is green light laser with a wavelength of 532nm which coincides with one of the absorbable peaks of oxyhaemoglobin. There is only minimal collateral extravascular thermal soft tissue trauma.

2-micron continuous wave laser:

It simulates the cutting and dissection characteristics of CO_2 laser but unlike a CO_2 laser, the energy is delivered by means of a fiber, which allows for tangential endoscopic dissection.

MATERIALS AND METHODS

Fifty patients with vocal dysfunction from the ENT out patient department of Upgraded Institute of Otorhinolaryngology, Chennai Medical College and Government General Hospital, who failed conservative medical and voice therapy requiring phonosurgical procedure were included in this study.

Study Design: Prospective study

Period of study: September 2006 to October 2007.

Inclusion Criteria:

Adult patients with benign vocal fold lesions and vocal cord palsy who failed with conservative medical and voice therapy, requiring phonosurgical procedure to correct their voice dysfunction were included in this study.

Exclusion Criteria:

a) Patients who had good response to conservative therapy.
b) Malignant lesions of the larynx causing vocal dysfunction.
c) Vocal cord palsy caused by neoplasms.
d) Medically ill patients.

All the patients with vocal dysfunction were examined and their pathological lesion identified. The patients with benign vocal fold lesions were given intense medical and voice therapy. Patients who failed the conservative therapy underwent phonosurgical procedures. Informed written consent was obtained from all the patients. Phonomicrosurgery was done for the patients with benign vocal fold mucosal disorders and medialization laryngoplasy using Gore-Tex was done for the patients with unilateral vocal cord palsy causing vocal dysfunction. The incidence and distribution of cases among the patients who require surgical intervention were analysed and categorized.

The outcomes & prognosis of the various phonosurgical procedures were analysed.

OBSERVATIONS AND RESULTS

The following data is obtained from the present series of 50 patients with vocal dysfunction who failed conservative therapy and underwent phonosurgeries at Upgraded institute of Oto-Rhino-laryngology, Government General Hospital attached to Madras Medical College, Chennai during the period of study from Sepember 2006 to October 2007.

DISCUSSION

Fifty patients with benign vocal fold lesion who failed conservative medical & voice therapy underwent phonosurgical procedures. Postoperative voice therapy along with medical therapy was given to all the patients. The socio-demographic data and the outcomes of the procedure were analysed and discussed.

CAUSES OF VOCAL DYSFUNCTION:

In our study, the order of frequency of various benign lesions of vocal cord causing vocal dysfunction were vocal cord polyps (40%), vocal cord nodules (16%), vocal cord cyst (8%), vocal cord papilloma (8%), Reinke's edema (6%), intubation granuloma (4%), recurrent respiratory papillomatosis (4%), Keratosis larynx (2%). Unilateral vocal fold palsy constitutes 12% among the lesions.
In a study by Zeitels et al (2002), Boston University, Massachusetts, vocal nodules constitute 55% followed by polyps 19%, cysts 18%, ectasias - 3%, Keratosis larynx 2%, granuloma 0.5%, Reinke's edema - 0.5%, Papilloma 0.5%.
In an Indian study made by Chatterji et al (1974) in Indian Journal of Otolaryngology, vocal polyps constitute 78%, nodules 10% and Reinke's edema 8%, others - 4%.

SOCIO-DEMOGRAPHIC DATA:

Age Distribution:

The age distribution in our study was

- 11-20 years: 6%,
- 21-30 years: 20%
- 31-40 years: 34%
- 41-50 years: 20%
- 51-60 years: 12%
- 61-70 years: 8%

Most of the patients fall into the age group of 21-50 years.

Sex Distribution:

The number of affected males were 52% and females were 48% in our study. The main aggravating factors were talkativeness, smoking & alcohol.

Incidence & Distribution of Unilateral cord paralysis:

In our study, 12% of the patients with vocal dysfunction requiring phonosurgical correction had unilateral vocal cord palsy caused by recurrent laryngeal nerve palsy as their etiology.
Totally six patients had unilateral vocal cord palsy. Five of them (83%) had developed cord palsy following thyroidectomy procedure. One of the patients had no relevant history to identify the cause for vocal cord palsy. He underwent panendoscopy and CT scan from skull base to upper mediastinum. With all these studies proved normal, the patient was categorized having idiopathic cord palsy.

Malignant lesions causing vocal cord palsy were excluded from the study.
Parnell & Brandenburg et al showed that trauma (including surgery) as the commonest cause of unilateral vocal cord palsy followed by neoplasm and idiopathic cause.
In our study 49% of the patients fall under the age group of 31-40 years. 83% of the females were affected with the male : female ratio of 1:4.8.

OUTCOME OF PHONOMICROSURGERY:

All the patients, before the surgical procedure, underwent intense medical and voice therapy. They were detailed about the vocal hygiene (including reduction of vocally abusive behaviours such as throat clearing, frequent hard glottal attacks, yelling or speaking incorrectly, condition such as dehydration and gastroesophageal reflux) and post operative voice therapy. The importance of vocal hygiene, smoking and alcohol cessation, reflux control, nature and risks of surgery were elaborated.
Phonomicrosurgical procedures done with operating microscope with 400mm objective lens. During the procedure, maximal importance was given to preserve the layered microstructure of the vocal folds. Epithelial cordotomy incision was made for most of the lesions and after removal of the lesion, the mucosal flap was redraped, serving as a biologic dressing. Small lesions were amputated with microscissor. Avulsion of the mucosal laryer was maximally avoided.
After the surgery, complete voice rest for one week was given for all the patients. Antibiotics, steroids and proton pump inhibitors were prescribed selectively. After one week, gradual increase of voice use with voice therapy was given over 3 to 6 weeks.
All the patients examined at the end of six weeks and their outcomes analysed.
Analysis of the outcome of the surgery was made with

- Subjective satisfaction of the patient.
- Auditory perceptual assessment by the surgeon
- Videoendoscopic analysis of the vocal folds.

Auditory perceptual assessment was made with GRBAS scale (G-grade or overall quality, R-Roughness, B-Breathiness, A-Asthenia, S-Strain) that was developed by the Committee for phonatory function of the Japanese Society of Logopedics and Phoniatrics.
It is a 4 point scale: 0 is for no deficit; 1 is for mild deficit; 2 is for moderate deficit, and 3 refers to a severe deficit. Patients with score ‘0’ were categorized as having good outcome, those with scores 1-2 were categorized as having fair outcome and those with scores 3 were categorized as failed surgery.
Videoendoscopic evaluation was done to look for the structure and mobility of the cords, regularity of the vocal folds and presence or absence of phonatory gap.
In our study, 90% of the patients who underwent surgery had good outcome and 10% of the patients had fair outcome. No failures were encountered.
In a study by Zeitels et al (2002), Boston University[37], who treated 185 patients with phonosurgery, 94% of the patients had good outcome.

OUTCOMES OF MEDIALIZATION LARYNGOPLASTY USING GORE-TEX:

Medialization laryngoplasty was done with Gore-Tex (expanded polytetrafluoroethylene). All the patients with unilateral vocal fold paralysis underwent laryngoplastic surgery after an average duration of 12 months after the onset of nerve paralysis.
The voice assessment was made after the completion of voice therapy at the end of 6 weeks.
In our study, 83% of the patients had good outcome and 17% of the patients had fair outcome. The fair outcome in one patient was due to inadequate medialization of the vocal cord.
In a study by Richard et al (2000) from Texas voice centre[38], Houston, 92% of patients who underwent medialization laryngoplasty had good outcome.

The merits of Gore-Tex evident from our study are its ease of handling, ease of adjustability of the implant inside the larynx, reduced operative time and its biocompatibility.

COMPLICATIONS:

- Laryngospasm occurred in 3 patients (6%).
- Tongue numbness occurred in 11 patients (22%).
- Loose tooth occurred in 4 patients (8%).

CONCLUSION

The present study on phonosurgery concludes

- Vocal polyp is the commonest benign lesion of the vocal cord that constitutes 40% in our study population.
- 21-50 years is the commonest age group affected with 74% of the patients fall in this age group. Males are affected more than the females.
- Proper investigation of voice & larynx provides the exact pathological nature of the lesion and determines the timing of surgical intervention.
- Thyroidectomy surgery is the common etiological factor in recurrent laryngeal nerve paralysis causing unilateral vocal cord palsy.
- Out study concludes that successful phonomicrosurgical resection of most commonly encountered lesions can be achieved and 90% of the patients had good outcome.
- The success reported herein is the result of improvement in our understanding of the microlayered structure of the vocal folds underlying the vibration and availability of phonomicrosurgical instruments that helps in preserving the layered microstructure of vocal fold.
- Most of the patients who underwent medialization laryngoplasty using Gore-Tex also had good outcome at the end of the voice therapy. Only one patient had fair outcome due to inadequate medialization of the vocal cord.
- The advantages of Gore-Tex include ease of handling, ease of placement, can be easily adjustable, enhances the speed of surgery and is biocompatible.
- No major complications encountered in our study on phonosurgeries.
- A team approach including good vocal rehabilitation is of paramount important in obtaining satisfactory outcomes in phonosurgery. The patient and the surgeon must approach phonosurgery collaboratively so that there is mutual responsibility for the decision to operate.

PROFORMA

Case No.	:		
Name	:	IP/OPNo.	:
Age	:	D.O.A.	:
Sex	:	D.O.D	:
Occupation	:	Diagnosis	:
Income	:	Results	:
Address	:		
Phone No.	:		

I. PRESENTING COMPLAINTS

2. Hoarseness of voice/change of voice :
3. Aphonia or Dysphonia :
4. Difficulty in breathing :
5. Cough during swallowing:
6. Difficulty in Swallowing :
7. Pain :
8. Fever :
9. Swelling in the neck :
10. Loss of weight :
11. Any other complaints :

II. PAST HISTORY

- ❖ History of Tuberculosis / Syphilis/ Leprosy
- ❖ History of infectious fever - Measles/Chicken pox/Typhoid
- ❖ History of trauma or allergy
- ❖ Surgery for any other disease in neck and throat
- ❖ History of irradiation
- ❖ History of diabetes or myxoedema
- ❖ Diseases of CNS

III. FAMILY HISTORY

- ❖ Similar complaints in any other member in the family
- ❖ History of T.B./Diabetes/ Hypertension

(a) Duration

(b) Onset

IV. PERSONAL HISTORY

- ❖ Diet/Sleep/appetite
- ❖ Micturation/bowel habits
- ❖ Habits : Smoking
  : Pan/Beetlenut chewing
  : Alcohol intake
  : Exposure to venereal diseases status
- ❖ Hygiene/Socio-economic Status
- ❖ Exposure to dusty atmosphere or chemical irritants or fumes etc.,

V. PHYSICAL EXAMINATION

(a) Built - Good / Moderate/Poor

(b) Nutrition - Good/Moderate/Poor

(c) Mental Status - Conscious/Co-operative

(d) Pallor / Icterus/Cyanosis/Clubbing / Pedal Edema

(e) Lymph-node status
Size/Shape/No/Consistency/Mobility/Overlying Skin

Vital Data
- Temperature
- Pulse
- Respiratory rate
- Blood Pressure

VI. SYSTEMIC EXAMINATION

(a) Cardiovascular system

(b) Respiratory system

(c) Per Abdomen

(d) Central Nervous systems

VII. ENT EXAMINATION

a) Examination of Throat

- Oral Cavity & Oropharynx
- Indirect laryngoscopic examination

b) Examination of neck

c) Examination of nose

- Anterior rhinoscopy
- Postnasal examination

d) Examination of ear

VIII. PROVISIONAL DIAGNOSIS

IX. INVESTIGATIONS

(a) Blood-Hb%/BT/CT/TC/DC/ESR
Blood Urea/Serum creatinine/Blood Cholesterol
Blood VDRL

(b) Urine - Albumin / Sugar/Microscopy

(c) Stool Examination for - ova / Cyst

(d) Sputum for AFB/ X-ray Chest /Barium Swallow / X-ray Neck

(e) Electroglottography

(f) Direct laryngoscopy / oesophagoscopy

(g) Flexibile fibreoptic laryngoscopy & bronchoscopy

(h) CT Scan from skull base to upper mediastinum

X. FINAL DIAGNOSIS

XI. MANAGEMENT

XII. FOLLOW UP

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